Appendix I

Draft Revegetation Plan

(Updated From IS/EA Document Draft Plan)

Robinson Reach Revegetation Plan

Reconstruction of the riparian corridor will largely eliminate the existing vegetation from approximately 256 acres of habitat. 190 acres of new floodplain surface, 33 acres of redesigned main channel and 33 acres of subsidiary wetland areas will be essentially devoid of vegetation immediately after earth moving ceases. A few surviving or newly germinated herbaceous plants will constitute the vegetative portion of the riparian ecosystem at that point.

Ecological functioning within the riparian corridor is tightly linked to the vegetation both within and beyond the floodplain. Nutrient input contributed by plants and the creatures that feed on them supports the aquatic network upon which the invertebrates, fish and other vertebrates of the riparian corridor depend. Shade and coarse woody debris also promote diversification of habitats within the riparian zone, modify temperatures within the water column, and provide refuge from predators. In order to meet the objectives of enhancing salmonid reproduction, survival and migration, revegetation with appropriate native species is an essential component of riparian restoration in the Robinson Reach.

Revegetation Goals

The goals of the revegetation plan are:

- Establish self-sustaining native riparian plant species.
- Maintain biodiversity and enhance riparian habitat values.
- Prevent invasive exotic plant species from dominating the new floodplain area or interfering with the restoration of the site.
- Compare cover and vegetative biodiversity of planted vs. naturally-regenerating portions of the reconstructed floodplain.

Specific objectives

- Cover of native woody riparian species will be 30% at the end of the five-year monitoring period.
- Survival of planted stock will be at least 70% after the first three years.
- Native riparian species will have survived at least three summers without irrigation by the end of the monitoring period.
- Cover of exotic weeds will not threaten the survival or growth of native plants. Certain invasive exotics will be completely eradicated from the site whenever they occur.

Specific actions required to meet these objectives will consist of:

- 99 acres of floodplain and portions of simulated abandoned channels will be planted with woody and herbaceous vegetation. These are to be native species currently found in or immediately adjacent to the Robinson Reach (See Table I-1). Planted material will include container plants grown from locally collected seeds and/or cuttings. Willow and cottonwood cuttings will be planted directly. Some herbaceous species, particularly grasses, will be seeded directly, as appropriate.

- Some 33 acres of seasonally and permanently inundated wetland areas (jurisdictional wetlands) will be allowed to regenerate naturally.

- Experimental areas of the floodplain and point bars (roughly 90 acres) will be allowed to regenerate naturally. Supplemental irrigation may be provided in order to enhance natural recruitment by simulating a "natural" inundation regime (see "recruitment box" hypothesis, Stillwater Sciences, 2000.)

- Irrigation systems will be installed to water plantings and to provide water to unplanted areas to assist in natural revegetation.

- Exotic invasive weeds will be controlled so that they do not compete with native vegetation or impede the restoration of the site. Certain species, such as giant reed (*Arundo donax*) will be targeted for complete eradication whenever they appear.

- Monitoring will be conducted on a yearly basis to obtain data on cover, density and diversity of native and exotic species, and to ensure that cover and survival objectives for native riparian species are met. (see Monitoring section below).

Site Description

The Robinson Reach is now a braided channel with sheet flow in some sections. The geologic setting for this reach is as follows:

The Miocene-Pliocene Merhten formation underlies the area and forms outcroppings along the southern cliffs (Marchand, 1976). This is composed of andesitic, angular, river-born sands, likely reworked from volcanic mudflows to the northeast. It is one of the most important aquifers in the region (Page and Balding, 1973). The Turlock Lake formation of early Pleistocene age forms larger outcroppings just to the south. This is composed of alluvial granitic sands and gravels overlying fine silt and clay. The river channel and floodplain are in, or immediately adjacent to, Tujunga, Hanford and Grangeville gravels, sands and loams. Gravel and cobble lenses are the prominent features visible when one visits this reach. The fines so necessary for lush riparian growth are here, but not abundantly. Judicious placement of smaller grain sizes during channel reconstruction will benefit the revegetation effort tremendously.

High flows in 1997 caused the main channel to be abandoned, resulting in approximately 6' of channel entrenchment at the upper end of the reach. This has lowered the water table so that significant numbers of century-old valley oaks (*Quercus lobata*) along the southern flank of the floodplain are dead or senescent. Aggregate extraction has created pools in the middle portions of the reach. Existing woody vegetation can be described as mature mixed riparian, riparian oak forest, mixed willow, willow scrub, and riparian scrub. Herbaceous communities include riverwash, non-native (weedy) grassland dominated by rice cutgrass (*Leersia oryzoides*) and large crabgrass (*Digitaria sanguinalis*) and seasonal and emergent wetlands.

The proportion of woody vegetation is presently between 15-20%; most of the site is sparsely vegetated riverwash and grassland communities. From aerial photographs in the 1940's, it appears that this proportion is more-or-less representative of the recent historical situation. The land was grazed by the Robinson family from approximately 1900 until 1997(Rhonda Reed, *pers.comm.).* Typically, this results in loss of willow and cottonwood cover. A remnant of riparian oak forest is found on the upstream end of the reach, and riparian oak forest is abundant on the Robinson property just upstream of the project area. Fremont cottonwoods (*Populus fremontii*) are present, if not abundant, along portions of the northern floodplain, in small patches of cottonwood riparian forest. Mixed-willow forest in this reach consists of Goodding's willow (*Salix gooddingii*), arroyo willow (*S. lasiolepis*), red willow (*S. laevigata*), shining willow (*S. lucida*) and buttonwillow (*Cephalanthus occidentalis*), and forms the majority of the woody vegetation found in the project area. Willow scrub is composed principally of sandbar willow (*S. exigua*) and young Goodding's willow. Willow scrub occupies most of the gravel bars subject to sheet flow since the 1997 high water event. Mixed riparian forest includes various willow species, with white alder *(Alnus rhombifolia*) and Oregon ash (*Fraxinus latifolia*) as prominent components, and California grape (*Vitis californica*) and Himalayan and California blackberries (*Rubus discolor* and *R. ursinus*) in the understory.

Reference Site

Just upstream of the project boundary, still on the Robinson property, is a twenty-acre site which can serve, in a limited fashion, as a reference site for revegetation on this reach. This site has high diversity and complex structure. Valley oaks, alders, ash and other riparian dominants are found on thick loam. Whiteroot (*Carex barbarae*) and the perennial creeping wildrye (*Leymus triticoides*) form thick stands in the understory, while California grape and California blackberry vines contribute structural diversity. The yellow-flowered *Bidens laevis* forms intensely showy patches in the wetlands during the late summer when most other species are not in flower, enhancing temporal diversity for pollinators. Species not common on the valley floor also occur, including spicebush (*Calycanthus occidentalis*), gray pine (*Pinus sabiniana*), buckeye (*Aeschylus occidentalis*) and yerba santa (*Eriodictyon californica*), among others. Surprisingly, Western sycamore (*Platanus racemosa*), a common component of riparian systems throughout central California, is apparently not known from the upper Merced River drainage. (Todd Keeler-Wolfe, pers. comm.; Dan Holland, unpublished data) nor the

lower (John Stella, Stillwater Science, *pers. comm.*). DWR staff visited sites throughout the upper drainage following rumors to the contrary, but no sycamores were found, although the exotic species, silver leaf maple (*Acer saccharinum*), and London plane tree (*Platanus occidentalis*) are common to abundant from the Robinson reach through Snelling and up to the New Exchequer Dam.

Hydrology

Riparian species are adapted to germinate and survive under particular flow regimes. Sandbar willow, alder, and buttonbush are generally found in close proximity to the main channel where inundation is most frequent, while Fremont cottonwood and valley oaks are generally higher on the floodplain or adjacent terraces. (USBR/DWR, unpub. data, 2000; Stillwater Sciences, 2000; also Holland, 1986). Along the Merced near Snelling, just upstream of the Robinson Reach, cottonwood forest is commonly found at inundation flows between Q_5 and Q_{10}, mixed riparian at $Q_{1.5}$, and riparian oak forest between $Q_{2.5}$ to Q_{25} (Stillwater Sciences, 2000). A map of probable inundation area for given Q values (flood recurrence intervals) along this reach was used to distribute the plantings at appropriate elevations to give each species the best chance of long-term survival once irrigation is removed.

Planting Plan and Methods

The planting scheme will utilize 50' hexagonal modules (see Figure I-1) of various compositions of native species of trees, vines and grasses, sedges and rushes to create a mosaic of riparian habitats (See module map, Figures I-2 and I-3, and species list, Table I-1). These are intended to become self-sustaining components of the floodplain which will approximate the mixed riparian, mixed willow, cottonwood riparian, willow scrub, and herbaceous communities described above.

Planting modules will cover 99 acres, including 96 acres of floodplain and 3 acres of the Simulated Abandoned Channels. The goal of establishing 30 percent cover of woody vegetation within 5 years should be well exceeded by these module plantings as well as by natural recruitment in the unplanted portions of floodplain, Simulated Abandoned Channels, and the backwater area.

Different module types are each based on a dominant species adapted to a particular inundation regime, i.e. Fremont cottonwood, white alder, Oregon ash, valley oak, etc. (See Fig I-1). The number of modules and their species composition are shown in Tables I-2a and I-2b. In most cases, strips and blocks of modules are at minimum 3 modules in width, with gaps of 1-2 module widths between. The gaps between modules may be larger than this (Figures I-2, I-3). Some strips of modules are arranged perpendicular to river flows in order to trap sediments and provide good substrate for natural recruitment. The placement of modules depends upon the hydrology, e.g., the modules containing sedges are nearer the low flow channel than those containing needlegrass, and cottonwoods are generally upslope of alders, etc. In part this placement is in accordance with observed relations in the area of the Robinson Reach

(Stillwater Sciences, 2000), and in part it is randomized within hydrologically-determined boundaries, in order to emulate natural stochasticity.

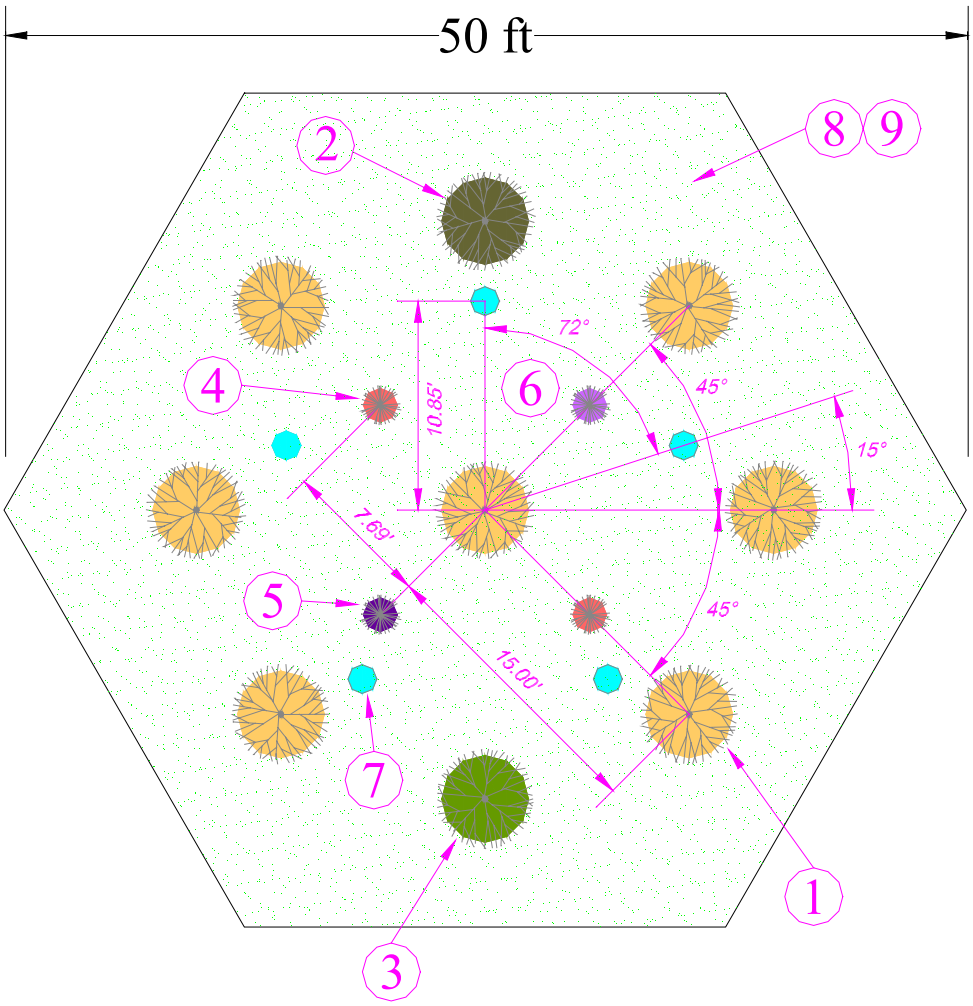
Scientific Name	Common Name	Plant code	Total Plants Needed
Acer negundo	Boxelder	ACENEG	2,923
Alnus rhombifolia	White alder	ALNRHO	1,036
Artemisia douglasiana	Mugwort	ARTDOU	7,059
Carex barbarae*	White root	CARBAR	120,092
Cephalanthus occidentalis	Buttonbush	CEPOCC	2,600
Fraxinus latifolia	Oregon ash	FRALAT	2,487
Juncus effusus	Common bog rush	JUNEFF	13,195
Juncus mexicanus	Mexican rush	JUNMEX	7,581
Leymus triticoides*	Creeping wild-rye	LEYTRI	55,458
Nassella cernua*	Nodding needlegrass	NASCER	9,630
Populus fremontii	Fremont cottonwood	POPFRE	3,252
Quercus lobata	Valley oak	QUELOB	952
Rosa californica	California rose	ROSCAL	3,762
Rubus ursinus	California blackberry	RUBURS	2,073
Salix gooddingii	Gooding's willow	SALGOO	2,675
Salix laevigata	Red willow	SALLAE	438
Salix lasiolepis	Arroyo willow	SALLAS	2,436
Salix lucida	Shining willow	SALLUC	408
Vitis californica	Wild grape	VITCAL	1,497
		Total	246,470

Table I-1 – Robinson Project Revegetation Plant List

(* Nursery stock is preferred, but given current budgetary constraints, direct seeding may be the best option for establishing these species)

	ABOX	BBSH	MWIL2	SEDG	BWIL	MVOKa	MVOKb	ABOX2
Total Mods	247	200	189	40	128	68	68	189
Species								
ACENEG	5		1			1	1	5
ALNRHO								
ARTDOU			4					
CARBAR*	38	77	36	115	77		36	
CEPOCC		13						
FRALAT	4		1			1	1	4
JUNEFF			29					
JUNMEX								
LEYTRI*	38		36			36	36	38
NASCER*						36		38
POPFRE						1		
QUELOB						7	7	
ROSCAL	2		2		1	2	2	2
RUBURS	1		1		2	1	1	1
SALGOO			3		9			
SALLAS								
SALLEA			2					
SALLUC			1					
VITCAL	1				1	1	1	1

Table I-2a – Total Modules and Number of Plants Per Module



Key	Plant Name	Species	No. Per Module
1	Cottonwood	Populus fremontii	7
2	Ash	Fraxinus latifolia	1
3	Boxelder	Acer negundo	1
4	Wild Rose	Rosa californica	2
5	Blackberry	Rubus ursinus	1
6	Wild Grape	Vitis californica	1
7	Mugwort	Artemisia douglasiana	5
8	Sedge	Carex barbarae	36
9	Creeping Wildrye	Leymus triticoides	36

Figure I-1 – Module Example (MCTN)
Note: Modified from HDR Engineering, Inc 1999, Tuolumne River Channel Restoration Project

	MCTN	COTN	MWIL	RWIL	MG	JUN	LEYT	ALD	Total
Total Mods	199	199	219	180	200	133	131	259	2679
Species									
ACENEG	1		1						2923
ALNRHO								18	1036
ARTDOU	5	4	4		13			4	7059
CARBAR*	36	36	36	77			115	79	120092
CEPOCC									2600
FRALAT	1		1						2487
JUNEFF						58			13195
JUNMEX						57			7581
LEYTRI*	36	36	36				38		55458
NASCER*									9630
POPFRE	7	9							3252
QUELOB									952
ROSCAL	2	2	2	2				2	3762
RUBURS	1	1	1	1				1	2073
SALGOO			2					2	2675
SALLAS			2						438
SALLEA			2	9					2436
SALLUC			1						408
VITCAL	1	1	1	1					1497

Table I-2b – Total Modules and Number of Plants Per Module

(*These species may be directly seeded as an option to using nursery stock)

Installation of plants

All planting will be done in the months of October through January.

Cuttings

Willow and cottonwood cuttings will be collected locally, preferably immediately prior to installation. Cuttings will be a minimum of 1” in diameter and 3’ long. Cuttings will not be allowed to dry out before installation. If cuttings are stored prior to installation, they will be kept in containers with water and protected from sun and drying. Cuttings will not be stored for longer than one week.

Cuttings will be installed in holes augered into the substrate to a depth of 2.5’, leaving a 6” stub with at least two bud nodes sticking out of the ground. Watering basins 2’ in diameter and 3” deep will be constructed around each cutting. Cuttings will be watered in immediately following planting by filling the watering basin two times.

Container Plants

Shrubs and trees grown from locally-collected seed will be planted in holes dug approximately 12” deep, then partially backfilled to form a mound in the center. Plants will be removed from the containers and the roots loosened, then spread out over the mound. Planting holes will be backfilled with a 50:50 mix of commercial planting mix and local substrate. Watering basins (see above) will be constructed around each planting, and the plants will be watered in after planting.

Oaks

Holes will be augered to a depth of 3' and backfilled with a 50:50 mix of commercial planting mix and local substrate. Watering basins will be constructed as above around each site. Three acorns will be set on their sides in the backfilled hole, and covered with planting mix about 1" deep to conserve moisture.

Acorns will be protected by a 3' tall tree tube staked at each site. Each site will be thoroughly watered after planting.

Plugs

Grass and sedge plugs will be planted in holes augered to the size of the container. The plugs will be removed from the container and the roots loosened around the outer surface of the root ball. The plug will then be placed in the hole and the substrate firmed around it. Each plug will be watered in after planting.

Direct Seeding of Herbaceous Plants

Direct seeding of herbaceous species may be a lower-cost alternative to nursery plugs. The acreages and species list are to be determined. Hydroseeding is one possible method of application, as is hand-spreading followed by raking.

Irrigation

Plants will be watered weekly or as needed during the dry season or during any period of two weeks without at least 1" of rainfall. Water will be sufficient to wet the entire root system of the plant or equivalent to a 1" rain. Watering methods will be determined following consultation with the property owner.

Weed Control

Weeds will be monitored on a monthly basis during the growing season (approximately March through September), and weed control will be such that weeds do not threaten the survival or growth of the plantings. Noxious weeds such as tree of heaven, giant reed, salt cedar and eucalyptus will be targeted for complete eradication. Star thistle will be controlled, with a goal of eventual eradication. Methods may include hand removal, mowing, and selective use of approved herbicides.

Plant Replacement

Acceptable mortality for container stock plantings, during the first three years of monitoring, is 30 percent. Annual assessment of container stock viability will be noted and replacement plantings will be installed where mortality is greater than the acceptable limit. Replacement of container stock will occur only during the first three years of the monitoring phase.

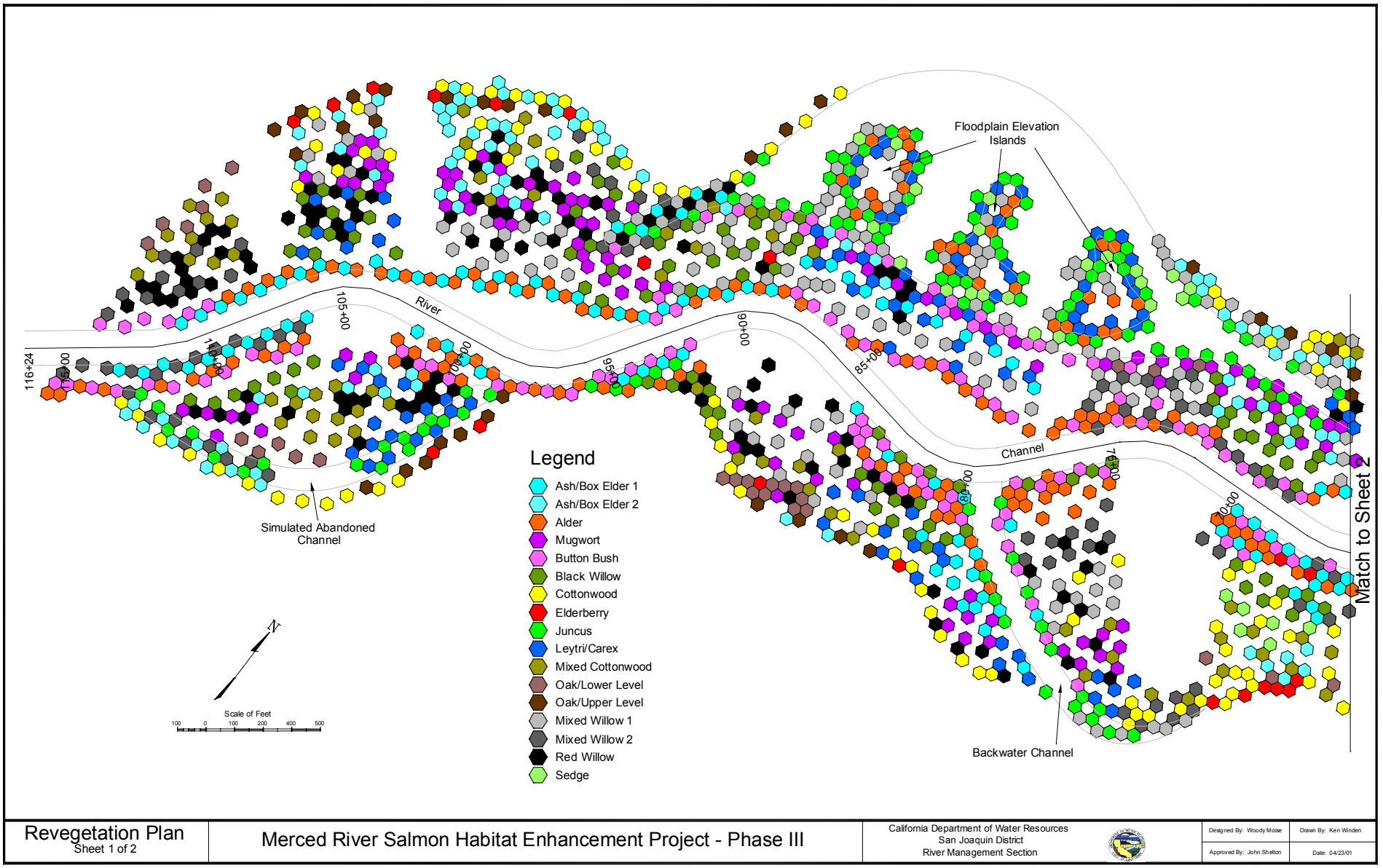


Figure I-2 – Revegetation Plan Layout Downstream

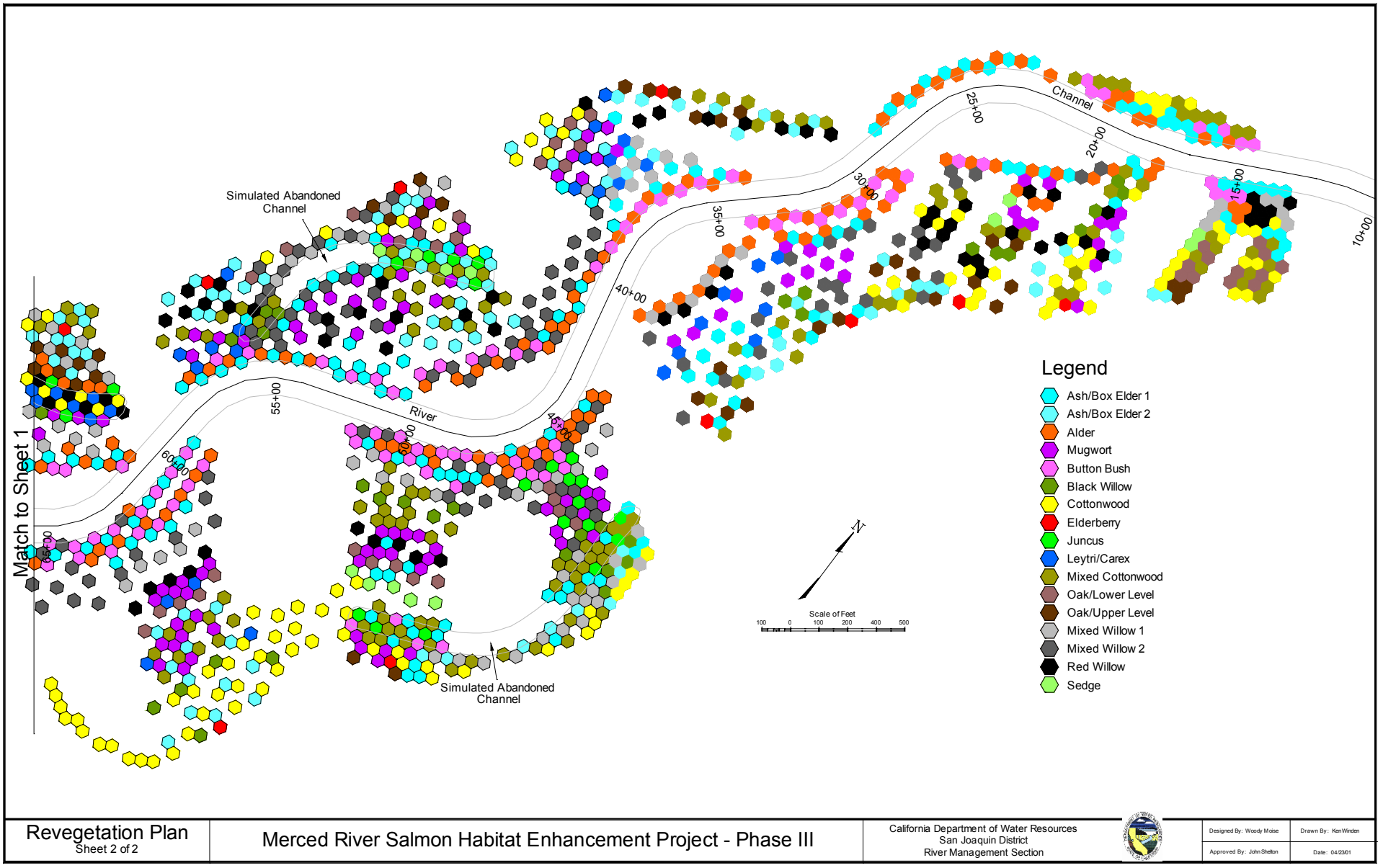


Figure I-3 – Revegetation Plan Layout Upstream

Predator Protection

A variety of methods may be used to control beaver and other rodent predation on plants which are establishing. Tree planting tubes and depredation permits are two possibilities which may be used, as appropriate.

Monitoring

The goal of the revegetation program is to create 30% cover of woody riparian vegetation over the floodplain areas, in addition to the approximately 35 acres of seasonal and permanent emergent wetland vegetation that is expected to develop within the SACs and along the margins of the low-flow channel. Monitoring will be conducted on a yearly basis to ensure that the goals of the program are met within the 5-year time frame. Monitoring methods include:

1) **Photo documentation:** photo stations (see map XX)--Approximately 10 locations to be chosen including the Highway 59 bridge, several points along the bluffs flanking the southeast project boundary, and also along the northwest project boundary. Photos will be taken twice yearly during the first two years and yearly thereafter, in January (first two years), and in June.
2) **Monitoring survival of planted areas:** Yearly survival counts will be conducted within 5 per cent of the planting modules (randomly assigned), during September/October. If observations indicate that certain areas show better survival that others, the survey area will be divided into poorly performing, adequately performing, and superior performing areas and planting modules randomly surveyed within those classes.
3) **Cover, density and size class data (woody vegetation):** 15 permanent line transects will be established at the end of construction (January of 2002) using engineering control points. The transects will be distributed at regular intervals along the riparian corridor and oriented approximately perpendicular to the axis of the constructed channel The ends of each transect will be at fixed distances from permanent rebar or t-posts installed above the floodplain. Yearly data on cover and species composition will be collected, using the line-intercept method. A 2-meter-wide belt transect centered on the line transect will allow collection of seedling and sapling recruitment data, as well as size classes of recruits. Transects will pass through both planted modules and experimental unplanted areas; data entry will differentiate between the two.
4) **Herbaceous species:** A ¼ meter square Daubenmire frame placed along the transect centerline at 5-meter intervals will be used to obtain cover class estimates for herbaceous species.

Data Analysis and Reporting

Data will be analyzed to provide the following:

1) **Total cover** of woody vegetation (percent)

2) **Percent cover of individual woody species**, both native and non-native

3) **Percent cover for both native and non-native herbaceous species**, including proportion of cover contributed by invasive exotic species

4) **Contrasts of cover proportions** between planted and unplanted portions of the restored floodplain.

5) **Weighted diversity indices** of planted vs. naturally-regenerated areas of the restored floodplain.

6) **Survival counts, cover and heights** of planted materials

Annual reports of vegetation monitoring will be submitted to the ACOE.

Remediation

If monitoring shows that the goals of revegetation are in jeopardy, appropriate action will be taken by the project managers to ensure that revegetation is successful. Such actions may include weed control measures, replanting to replace dead stock, or other adaptive measures.

References

Holland, 1986.

Marchand, Denis E. 1976. USGS Open-File Report 76-836. Preliminary Quaternary Geologic Map of the Northern Merced Area, California, Yosemite Lake Quad.

Page, R.W., and G.O. Balding, 1973. Geology and Quality of Water in the Modesto-Merced Area San Joaquin Valley, California. Water-Resources Investigations 6-73, p.22.

Stillwater Sciences, 2000. Merced River Restoration Plan, Phase II: Baseline Evaluations, Geomorphic and Riparian Vegetation Investigations Report (Draft). Stillwater Sciences, 2532 Durant Avenue, Berkeley CA 94704.

USBR/DWR Unpublished data on Riparian Vegetation of the San Joaquin River, collected Summer, 2000.